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Glycemic Control and Type 1 Diabetes Mellitus: Current Standard Treatment vs. Closed-Loop Insulin Pumps

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Abstract

• As of 2015, 9.4% of the US population had a diagnosis of Diabetes Mellitus (DM). Although most of the data which studies encompass type 1 (T1) and type 2 (T2) DM data in all ages of patients, the focus of this project will be on T1DM.

• There are effective methods currently available for the management of T1DM patients. These methods include: closed-loop insulin pumps that integrate a continuous glucose sensor (CGM) and insulin pumps into one effective system that calculates the needed insulin doses through complicated algorithms, CGM with self-blood glucose monitoring (SBGM) and insulin administration, and SBGM with insulin administration.

• Literature reveals that closed-loop insulin pumps have the potential to provide better glycemic control, decreased treatment outcomes for those patients who are motivated to use them as directed and find them a desirable option.

• When patients can effectively manage their blood glucose, and practice healthy lifestyle and dietary choices, they can avoid unnecessary hospitalizations and long-term diabetic complications. This will simultaneously reduce healthcare-related costs, increase longevity and can improve the patient’s quality of life.

Introduction

• According to the CDC, DM affects 30.3 million people in the US. Five percent of adults got less than 10 minutes/week of moderate to vigorous activity in 2017, which is not consistent with scientific evidence of effectiveness, not unreliable reports and should be appropriately prescribed for use in patients that can manage them efficiently and are motivated to do so. Closed-loop systems should be strongly considered as a long-term management method in patients with T1DM.

DIABETES MELLITUS type 1

• The CDC (2017) states that in 2014, a total of 3.1 million hospital discharges and 14.2 million emergency department visits were reported with diabetes being listed as any kind of diagnosis among US adults aged 18 years or older. The total direct and indirect medical expenditures related to diabetes in the US in 2015 was $245 billion; with an average of $175,700/person being medical expenditures related to diabetes. This is a 1.7 times higher healthcare expenditures for people without diabetes. It is also important to note that DM was the seventh leading cause of death in the US in 2015.

Statement of the Problem

• Current medical treatment for diabetes patients require self-blood glucose monitoring, this monitoring is done using self-blood glucose monitors (SBGM), which results in many finger sticks.

• Insulin injections can be performed by the patient or by an insulin pump that must be manually programmed, which requires the patient to be proficient at calculating insulin doses independently. It is high potential for error related to insulin administration due to incorrect calibration of the glucometer or basic human error.

• When patients practice good blood glucose management they can avoid unnecessary hospitalizations and other diabetic complications, which will simultaneously reduce healthcare-related costs. These choices should be based on scientific evidence of effectiveness, not unreliable reports and should be made after considering the patient’s lifestyle and its impact on each method’s particular benefits and challenges.

• The CDC (2017) states that in 2014, a total of 10.4 million hospital discharges and 16.4 million emergency department visits were reported with diabetes being listed as any kind of diagnosis among US adults aged 18 years or older. The total economic cost of diagnosed diabetes in all ages of patients, the focus of this project will be on T1DM.

• Current medical treatment for diabetic patients require self-blood glucose monitoring, this monitoring is done using self-blood glucose monitors (SBGM), which results in many finger sticks.

Research Questions

• Will closed-loop insulin pumps provide better efficacy by monitoring glycemic control according to patient’s blood glucose levels and glycated hemoglobin levels (HgbaC) and decrease the incidence of hypoglycemic episodes, as compared to the current standard treatment of insulin pump therapy in patients with T1DM?

• What are the unique benefits of the different effective T1DM management methods?

• What are the challenges of these management methods and how will they affect their actual use-effectiveness?

Literature Review

• The DCCT performed by Nathan, et al. (2013) demonstrated a drop of nearly ~2.5% in HgbaC and a slowed rate of loss in C-peptide responsiveness in Beta cell preservation. The CDC performed by Nathan, et al. (2011) demonstrated the need for earlier intervention in T1DM by showing that it can reduce severe renal impairment by ~51%, risk of primary CVD outcomes by 25%, and nontaral MCI or stroke by 38%. The DCCT performed by Nathan, et al. (2013) demonstrated a drop of nearly ~2.5% in HgbaC and a slowed rate of loss in C-peptide responsiveness in Beta cell preservation. The CDC performed by Nathan, et al. (2011) demonstrated the need for earlier intervention in T1DM by showing that it can reduce severe renal impairment by ~51%, risk of primary CVD outcomes by 25%, and nontaral MCI or stroke by 38%.

• The DPP (2017) shows an improvement in the INT group with the following outcomes: HgbaC by three to six months to a level of 6.0% from the initial 9.5% . Micrrocuv - results found were consistent, significant, and clinically meaningful. Cardiovascular - the population participant was generally young and healthy to experience major CVD events: p=0.255 INT group with three events in three subjects vs. CONV with twenty one events in seven subjects. Beta cell preservation – INT group slowed the rate of loss of C-peptide responsiveness by ~51%.

• The DCCT performed by Nathan, et al. (2013) demonstrated a drop of nearly ~2.5% in HgbaC and a slowed rate of loss in C-peptide responsiveness in Beta cell preservation. The CDC performed by Nathan, et al. (2011) demonstrated the need for earlier intervention in T1DM by showing that it can reduce severe renal impairment by ~51%, risk of primary CVD outcomes by 25%, and nontaral MCI or stroke by 38%.

Common Risk Factors for Diabetic Complications

- Smoking
- Hypertension
- Physical inactivity
- Obesity
- Low HDL
- High Cholesterol
- Hypertriglyceridemia
- Family history of diabetes

References


Application to Clinical Practice

• Initial management of a T1DM patient should include basic disease education, demonstration of SMBG and insulin injection methods, how to recognize and treat a hypoglycemic episode, and how to measure either blood or urine ketones concentrically. Close monitoring of the patient’s daily logbook by the team that should ideally include an endocrinologist, a certified nurse educator, dietitian, and possibly a mental health professional to provide support if the need should arise.

• As potential future family practice providers, we must consider our patient’s lifestyle, education, and family history when assessing disease control, and socioeconomic status to adequately make a choice for their T1DM management regimen.

• SBGM and insulin injections are relatively inexpensive, whereas newer technology is initially more expensive, but provide better efficacy and ease of use and also decrease in hypoglycemic events and hospitalizations. Clinicians must be mindful of what type of insulin delivery system that they are recommending for each patient.

• Closed-loop systems have proven themselves effective; and can lessen disease burden on the patient’s lifestyle. They are appropriate to prescribe for use in patients that can manage them efficiently and are motivated to do so. Closed-loop systems should be strongly considered as a long-term management method in patients with T1DM.

Discussion

• Historical studies show that an intensive insulin regimen along with strict monitoring of blood glucose and HgbaC levels provide patients with less long-term microvascular side effects of retinopathy, neuropathy, and nephropathy, as well as the microvascular side effects of cerebral vascular disease.

• The DCCT performed by Nathan, et al. (2013) demonstrated a drop of nearly ~2.5% in HgbaC and a slowed rate of loss in C-peptide responsiveness in Beta cell preservation. The CDC performed by Nathan, et al. (2011) demonstrated the need for earlier intervention in T1DM by showing that it can reduce severe renal impairment by ~51%, risk of primary CVD outcomes by 25%, and nontaral MCI or stroke by 38%.

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